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ABSTRACT

This packet contains information on teaching about environmental impact. Background information is included on the role of environmental impact on our society and environmental risk is also discussed. Environmental impacts are studied using Stages of Assessment. Learning activities and seven lesson plans include: (1) "The Community Initiative"; (2) "Call Out the Engineers"; (3) "The Business Meeting"; (4) "What Is the Environment?"; (5) "How Great Is It?"; (6) "How Important Is It?"; and (7) "One Voice, One Vote." Each lesson plan contains an introduction to the activity, an objective, student materials, suggested procedures, and worksheets/tables needed to complete the lesson. (SAH)

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ASSESSING ENVIRONMENTAL IMPACT

A Secondary School Learning Activity

by

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Teaching Module Introduction

When a construction project is proposed, the builder must consider needs, costs, risks and benefits. These considerations are presented mainly in engineering and economic terms. However most people today realize that the effects of any project on public health and the environment are also important concerns. In addition to engineering and cost analyses, there should be a detailed account of possible effects of the proposed construction project on the environment. Some questions that arise are, "How will we pay and benefit from the project?"..."What effects will construction and the completed project have on me, my family and the environment?"..."What are the long term implications of my reporting, or not reporting, something I believe or know about the project?"..."Am I willing to accept the risks and consequences?' When you put together the answers to these and other questions, along with a detailed account of the costs, you have an Environmental Impact Statement.

In these impact statements, you can identify peoples' viewpoints and perceptions about effects that the project may have on the environment. In American society we have Constitutional support for life, liberty, pursuit of happiness, free enterprise and free expression of speech according to one's beliefs and convictions. We uphold and defend these rights! But sometimes it seems as though certain groups of people or individuals are very good at doing things at our expense. In other words it seems as though special interest groups do what they see as important while using our time, tax dollars, ideas and our environment. While free enterprise gives individuals and special interest groups the right to get involved, it also guarantees our right to get involved or give reactions and viewpoints right from the start.

We live in a participatory democracy. If an individual or group delays participation, it does not mean that everybody must stop what was started and wait for that individual or group to "catch up." As a citizen each of us has the right to contribute, as well as the obligation to eliminate future injustices to people and the environment. As citizens we assume the responsibility to critically analyze issues, viewpoints, actions, omissions to recognize potential problems and seek successful solutions to these problems.

All too often, people think that they must have a special degree or professional background to get involved with writing an environmental impact statement. While that may have been the case in the past, it does not appear to be the trend, now or for the future. More citizens are becoming involved with environmental advisory councils,

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community agencies, or are serving on committees alongside physical and social scientists and engineers to build our society. In addition, the Internet has opened information access and communication route to others. Discussing or reviewing environmental impact statements involves many people with different viewpoints working on a team.

The students working through this module will initiate and analyze proposed projects and assign values to their probable impacts. It is obvious that this type of analysis does not produce an overall and absolute quantitative rating or score but allows individual value judgments to emerge and be examined by students for their relevancy, appropriateness and worth. This is important especially in a society where 'zero risk' does not exist! The main goal is to insure that the impact of alternative actions is considered and evaluated. Today impact, to use an old cliché, is the name of the game!

SOME BACKGROUND

Environmental Impact

The National Environmental Policy Act of 1969 (NEPA) directed all agencies of the Federal Government to ".... identify and develop methods and procedures which will insure that presently unqualified environmental amenities and values are given appropriate consideration in decision making along with economic and technical considerations (Council on Environmental Quality, 1971)." The Council on Environmental Quality set guidelines for preparing an environmental impact statement (EIS) (http://www.nrc.gov/NRC/NUREGS/SR1437/S1/index.html). In some instances the statement is referred to as an Environmental Impact Assessment (EIA). EIA is the systematic examination of the likely impacts of development proposals on the environment prior to the beginning of any activity. The term, EIA, is derived from NEPA Section 102 (2). For the first time those proposing to undertake certain projects had to show that their projects were not going to significantly affect the environment. They had to produce an Environmental Impact Statement (EIS) to show the nature and scale of their project, the affected environment, and the likely impacts and measures taken to reduce/monitor these impacts.

In principle, EIA should apply to all actions likely to have a significant environmental effect. The potential scope of a comprehensive EIA system is considerable and could include the appraisal of policies, plans, programs and specific projects. EIA as it has developed in many countries involves a number of procedures and stages :

- Identification of projects requiring EIA, sometimes known as screening;
- Identification of the key issues to be addressed in an EIA, called scoping;
- Impact assessment and evaluation;
- Impact mitigation and monitoring;
- Review of the completed EIS; and
- Public participation. (http://kola.dcu.ie/~environ/eia.htm)

The result of an EIA is assembled in a document known as an Environmental Impact Statement (EIS)

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which looks at all the positive and negative effects of a particular project on the environment. This report is just one component of the information required to aid decision-makers in making choices about a project. EIA can be considered as a mechanism maximizing the efficient use of natural and human resources. It reduces cost and time taken to reach a decision by ensuring that subjectivity and duplication of effort are minimized. It also identifies and evaluates the primary and secondary consequences that might require the introduction of expensive pollution control equipment or compensation and other costs at a later date. From the European Union to Australia and throughout the United States (http://tis.eh.doe.gov/nepa/links/links.htm) environmental assessment is valued and legislatively mandated. In some countries, it is not!

Be that as it may, the language of the act is very complicated and certainly does not read like a story. However the complex guidelines were translated by the United States Geological Survey Department into a somewhat simple yet comprehensive procedure for evaluating or assessing environmental impact (Leopold. et al. 1971). The USGS procedure is considered timely and appropriate as the basis for the instructional activities in this classroom simulation module.

Environmental Risk

To obtain public participation in the decision-making process and get people to vote we need to better educate them in examining environmental risks. Americans are risk conscious but popular reaction to unacceptable risk is hard to define (Barthauer, 1986). For example, the risk of death by driving a car for 200,000 miles is greater than the risk of death by flying 50,000 miles on a commercial flight. But most people would rather drive than fly.

The perception and acceptance of risk often depends more on:

- *Possible consequences of exposure rather than probability of occurrence*; The possible consequences of a lower risk, such as getting cancer from living within 20 miles of a nuclear power plant for 70 years, may be less palatable than those of a higher risk like taking a 10 mile canoe trip.

- *The number and viewed status of people affected negatively by the risk versus those individuals benefiting*; In many cases this is an equity issue where risk exposure falls upon one subgroup disproportionately while benefits are distributed to a larger group. The larger group and subgroup may see risk as acceptable but usually do not believe the subgroup, alone, should bear the full burden.

- *Who controls the risk*; People feel less vulnerable in situations where they have control, such as contributing to and creating the risk of pollution through waste production, rather than in situations where they have no control, like feeling more vulnerable to the risk of death by a drunk driver.

- *The perceived necessity of accepting the risk*; The necessity of accepting risk is highly individualistic and is tempered with a sense of social concern. For example many people feel it is not necessary to have a waste dump next to their back yard and someone else should have it!

- *How the risk is communicated*; Many special interest groups use "fear' communications and statistics to promote their position. Risk assessment is considered a necessary activity in environmental impact assessment. The goal of communication should be to help the public put risk in perspective. Strict reliance on statistics ignores values and ethical consideration in risk assessment. Statistics "overload" is another reason why many public policy decisions fail to receive public approval.

- *People want industry and government to provide the best available protection from risks*; The public demands safety and is unwilling to trade off concern for health for increased economic benefits. This mandate in American public policy means safety in the environment will come with a high price tag.

It is clear we do not live in a risk-free society. This important reminder must be repeated in discussions around the dinner table, the community meeting room, the science and social science laboratories, the corporate boardroom, Federal and state environmental agencies, the courts, and we hope, in the "sciencing classroom." There is a saying that "Charity begins at home." In this module, charity toward the environment begins in our classroom.

STUDYING ENVIRONMENTAL IMPACT

To develop an impact statement regarding the effect of construction or project on the environment, participants follow a sequence of events. These events, referred to as **STAGES OF ASSESSMENT** are as follows:

- *Describing the System* - project objectives are outlined and accurate data about important variables in these objectives are obtained.
- *Selecting the Technology* - technological alternatives for achieving the objectives are examined.
- *Proposed Action Plans* - practical ideas for achieving each stated objective are proposed. Monetary benefits and costs are detailed.
- *Analyzing Environmental conditions* - before any action is taken, characteristics and conditions of the existing environment are listed.
- *Determining Magnitude* - relationships between proposed actions and actual environmental conditions are explored and those most important in regulating the system are determined. Based on a determination of how much will the variable have on the environment, a numerical value is generated. Although in some details, this determination is subjective it must nevertheless be factual and unbiased in orientation.

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- *Determining Importance* - the importance of the variable on the environment is translated into a numerical value. This determination considers consequences of changing the variable on other factors in the environment. The importance of impact is based on value judgments of each evaluator and likewise must be factual and unbiased in orientation.
- *Recommendations* - concluding statements, summaries, and recommendations are prepared. This recommendation discusses the (a) relative merits of various proposed action plans, (b) rationale behind the final choice of action, and (c) plan for achieving the objective identified in stage one above.
- *Vote on the Recommendations* - all individuals in class, as citizens and irrespective of the group in which they played roles, vote to accept one and reject all other recommendations.

THE LEARNING ACTIVITIES

Learning activities focus students' attention on the active assessment and discussion of environmental impacts of solutions. Each student participating joins or is assigned to a group (1) Community Initiative, (2) Environmental Advisory Council, (3) Engineer, (4) Media, or (5) Citizen. The student within the group is expected to learn more facts, problems, issues and potential solutions. Students may view and use photographic slides, the Internet, technical references, as well as other publications, to gain information and insights to enhance their roles in the above groups. All students are citizens but each one participates in one or more small decision-making groups as individuals having certain values, biases and roles. Activities are designed for use with the total class where each member is involved with a group in one or more of the stages of assessment outlined previously and in Table 1 below.

Table 1

Groups and Stages of Assessment

Group	Stage of Assessment Initiated
Community Initiative and Engineer	(1) Describing the system (2) Selecting the technology (3) Proposed actions
Environmental Advisory Council	(4) Analyzing environmental conditions
Any and all students	(5) Determining magnitude (6) Determining importance
Media	Publicizes information relative to any stage of assessment
Any and all students	Speak out relative to any stage of assessment
Environmental Advisory Council	Make recommendations
Any and all students	(7) Vote on the recommendations

Note. Associated lessons in parenthesis

Given a plan for a proposed project, the student engages in one or more of the first four stages of assessment. He or she determines the magnitude and importance of each plan, and votes on the recommendation proposed by the impact statement committee. The behavior of the student should demonstrate knowledge and ethical behavior as a citizen in a participatory democracy. The exercises or activities are designed as a seven to ten lesson sequence of approximately 45 minutes each, involving class discussion, small group meetings, library research, homework, oral presentations, and voting on the recommendations. It is expected that the teacher will use her or his judgment as to the activity time required in and out of class as well as the total length of time that can be spent on the activity. Again, the scheme for the exercise and the groups is outlined in table one. Certain actions are not numbered. These do not occur normally in an impact statement but do in society and are therefore included in this total classroom simulation.

Lesson Plans

Activity 1. "The Community Initiative"

Students interested in finance, environmental law, business, politics, community affairs, and technical advising join this group and identify the "community initiative" project they want to finance. The scope of the project is outlined and a realistic cost figure for the project is identified. A proposed project report is written. Although activity 1 focuses on the community as initiator of the proposed project, other interest groups may initiate projects. Likewise, the intent is not to create a business versus environmentalist situation

Objectives: Given a PROPOSED PROJECT REPORT SHEET (SM 1.1), students electing or assigned to the community initiative group discuss and select a "big business" project they want to finance. The objectives of the project, as well as an estimated and realistic cost figure are written. It should represent a possible or actual project within their community or town.

Organizing ideas: Budget, faction, interest group, peers, public opinion, revenue sharing, and expenditure.

Student materials: Proposed Project Report (SM 1.1)

Suggested Procedures:

1. Ask some students to volunteer as "community initiative" financiers. If no students volunteer, you, as teacher, may initiate the project or assign students to the group.

2. The Proposed Project Report sheet (SM 1.1) is the means for students to discuss and write down their idea for the project. Stress clarity of expression and concise wording.

3. Provide ample opportunity for the students to obtain realistic estimates of the costs involved. The handout (SM 1.1) might be distributed and examined on a Friday (Perhaps after introduction of the module) and completed by the end of the period on Monday after group sharing and discussion of alternatives. This activity is intended to stimulate student awareness, involvement, and willingness to pursue the issues.

4. Ask students such questions as:

- Why do you want this particular project?
- Who will the project benefit directly or indirectly?
- How did you estimate the time to complete the project?
- How do you know the budget is realistic?

PROPOSED PROJECT REPORT (SM 1.1) OF THE COMMUNITY INITIATIVE GROUP

Date: _____ Prepared by: _____

The title of the project we propose is:

Brief description of the proposed project:

Total proposed time of the project yrs. _____mos.

Total proposed cost of the project $_____

Activity 2. "Call Out the Engineers"

The engineers take the community initiative group's Proposed Project Report and identify any (1) modification of the environment, (2) land transformation, (3) resource extraction, (4) industrial processing, (5) resource renewal, (6) changes in traffic, (7) waste emplacements and treatment, or (8) possible sources of accidents associated with the project.

Objectives: Students in the engineering group meet with members of the community initiative group and are given a checklist of proposed actions (SM 2.1) and identify the actions considered necessary to complete the project.

Organizing Ideas: Modification of the environment, land transformations, resource extraction, industrial processing, land alteration, renewed resources, changes in traffic patterns, waste emplacements and treatment, chemical treatment, and possible sources of accidents.

Student Materials: Handout entitled PROPOSED ACTIONS CHECKLIST (SM 2.1); only one checklist per project is recommended.

Suggested Procedure:

1. Allow students in the engineering group to meet at least once with community initiative group and discuss the project. The engineers then meet separately to complete the Proposed Actions Checklist.

2. The proposed actions on the checklist are designed to make students aware of the number of variables associated with a project. It is assumed that a majority of the students will not have the knowledge background regarding definitions of many of the terms. This may require your working with the group as a "technical advisor."

3. Members of the engineering group may wish to construct a map or rendering of the region where the proposed project will be implemented.

4. Students submit checklist to the community initiative group preparing for activity #3.

PROPOSED ACTION CHECKLIST SM 2.1

Check those boxes [ ] showing actions required for the project. Mark specific *items in italics* to help you remember why you checked the box.

[ ] Modification of Environment by introducing or changing: *exotic plants or animals, biological controls, habitat, ground cover or water, drainage, river or canal control and flow, irrigation, weather, burning, surface or paving, or noise and vibration*

[ ] Land Transformation and construction by: *urbanization, industrial sites, buildings, airports, highways, bridges, roads, trails, railroads, cables, lifts, transmission lines, pipelines, corridors, fencing, channel dredging, straightening and revetments, canals, dams, impoundments, piers, seawalls, marinas, sea terminals, offshore structures, recreational structures, blasting, drilling, cut and fill, tunnels, and underground structures*

[ ] Getting Resources by: *blasting, drilling, surface, subsurface excavation, retorting, well drilling, fluid removal, dredging, clear cutting, lumbering, commercial fishing, hunting*

[ ] Processing materials in: *farming, ranching, grazing, feed lots, dairying, energy generation, mineral processing, metallurgical, chemical, or textile industries, automobiles, aircraft, oil refining, food, lumbering, pulp and paper mills, product storage*

[ ] Land Alteration by: *erosion control, terracing, mine sealing, waste control, strip mining rehabilitation, landscaping, harbor dredging, marsh fill or drainage, landfill excavation*

[ ] Resource Renewal by: *reforestation, wildlife stocking or management, ground water recharge, fertilizer application, waste recycling*

[ ] Changing Traffic of: *railways, automobiles, trucking, shipping, aircraft, river or canal traffic, pleasure boating, trails, cables, lifts, communications, pipelines*

[ ] Waste Disposal and Treatment using: *ocean dumping, landfill sites, burial or spreading of tailings, spoil and overburden, underground storage, oil well flooding, deep well burial, cooling water discharge, municipal waste discharge including spray irrigation, liquid effluent discharge, stabilization or oxidation ponds, septic tanks, stack and exhaust emission, spent lubricants*

[ ] Using Chemicals in: *fertilization, deicing of highways, stabilization of soil, weed control, insect control with pesticides, control of leaching*

[ ] Possible Accidents by: *explosions, spills leaks, operational failure*

[ ] Management through: *laws, regulations, financing, fees, energy sales, bonds*

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Activity 3. "The Business Meeting"

This activity requires students in the engineering and community initiative group to meet. They discuss the feasibility of the proposed project and prepare a final draft of the Proposed Project Report that includes a cost breakdown of the items on the proposed action checklist (student module 2.1) as they relate to the project. In addition, homework to identify realistic cost figures could involve such activities as conversations with parents and representatives of local businesses that might contract or bid on such a job. This is an excellent opportunity for the teacher to establish some home-school-community relationships. It enhances the teacher's image and minimizes any problems students might encounter in seeking out such information.

Objective: Given the Proposed Project Report Sheet (SM 1.1) and the Proposed Actions Checklist (SM 2.1), students in the community initiative and engineering groups meet to prepare a final draft of the Proposed Project Report Sheet, which is submitted to the Environmental Advisory Council.

Organizing Ideas: (Refer Activities 1 and 2)

Student Materials:
PROPOSED PROJECT REPORT SHEET (SM 1.1; completed in activity 1)
PROPOSED ACTIONS CHECKLIST (SM 2.1; completed in activity 2)

Suggested Procedure:

1. Have students in this group discuss if the wording on the Proposed Project Report Sheet (SM 1.1), needs to be rewritten. Keep the wording general yet concise and specific enough to be written on the one page report sheet.

2. Have students discuss whether to "cut" or "add" actions to the Proposed Actions Checklist (SM 2.1).

3. Have the combined group prepare a final draft of the proposed Project Report Sheet if necessary, and submit it along with the Proposed Actions Checklist, to the Environmental Advisory Council after Council has completed Activity 4.

Activity 4. "What is the Environment?"

A group of students in the Environmental Advisory Council Group use the checklist of the characteristics and conditions of the existing environment and identify those features that best characterize the actual environment in which they live.

Objective: Given the Environmental Conditions Checklist (SM 4.1), students in the Environmental Advisory Council identify the characteristics and conditions of the environment.

Organizing Ideas: Physical and chemical characteristics, biological conditions, atmosphere, fauna, flora, cultural factors, aesthetic and human interests, cultural status, and ecological relationships are all part of environmental conditions.

Student Materials:

Handout ENVIRONMENTAL CONDITIONS CHECKLIST (SM 4.1)

Suggested Procedures:

1. Allow time for the Environmental Council to meet and identify features and conditions that best characterize the actual environment in which they live.

2. Have the council complete the Environmental Conditions Checklist. (SM 4.1)

3. Post the checklists from activities 3 and 4. Copies of the checklists are given to the

a. Media Group

b. Citizen Group, and

c. A recorder (who prepares a "reduced matrix" for activity *5.)*

NOTE: AT this point in time a number of events may occur. The community initiative and engineering groups may lobby for media, citizen, and council support. Media groups may align with or attack the proposed project. Citizen factions may emerge either supporting or opposing the project. Student discussion in and outside of the classroom may be high. Other classrooms in your school could be polled on what they would prefer. Other class reactions might be compared with your own class' orientation. In all of this your style of teaching is an important consideration. What is required is a teacher who will serve as a resource person using a balance of directive and non-directive approaches with the students as they decide on the how, what, when, where, and why of this project. In terms of management however, it would be appropriate for you, as teacher, to be quite direct in maintaining order and promoting self-discipline on the part of the students.

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ENVIRONMENTAL CONDITIONS CHECKLIST **SM 4.1**

Check only those boxes [ ] showing the actual condition in your environment. Mark the specific condition to help you remember why you checked the box.

Physical and Chemical Characteristics

[ ] Earth: *minerals, soils, land form, force fields and background radiation, unique features, salinization*

[ ] Water: *surface, ocean, underground quality, temperature, recharge, snow, ice, and permafrost, salinization, eutrophication*

[ ] Atmosphere: *quality, gases, particulates, climate (micro, macro), temperature*

[ ] Interactions: *floods, erosion, deposition, sedimentation, precipitation, solutions, ion exchange, ion complexing, compaction and settling, stability (slides, slumps), stress-strain (earthquake), air movements*

Biological Conditions

[ ] Flora: *trees, shrubs, grass, crops, microflora, aquatic plants, endangered species, barriers, corridors, diseases*

[ ] Fauna: *birds, land animals, reptiles, fish and shellfish, benthic organisms, insects, microfauna, endangered species, barriers, corridors, disease vectors, food chains*

Cultural Use Factors

[ ] Use of environment for: *wilderness and open spaces, wetlands, forestry, grazing, agriculture, residential living; commerce, industry, mining, quarrying*

[ ] Human Aesthetic Interest in: *scenic views, wilderness, open space, landscape design, unique physical features, parks and reserves, monuments, rare and unique species or ecosystems, historical or archeological sites and objects, presence of misfits, hunting, fishing, boating, swimming, camping, hiking, picnicking, resorts*

[ ] Cultural Status: *cultural patterns, life style, health and safety, employment, population density*

[ ] Man-made Facilities and Activities: *structures, transportation network, movement, utility networks, waste disposal, barriers, corridors*

Preparing for Activity 5.

To generate discussion it is necessary to prepare a "reduced matrix" template for use by the entire class. This is done either as a homework or lesson planning assignment, which is done by the student or teacher, respectively. To facilitate large class presentation, using a transparency or large poster is recommended.

A "reduced matrix" template is nothing more than a listing of the Environmental Conditions Checklist items from SM 4.1 that apply to the project, and are written on the horizontal axis (or columns) of a matrix, and a listing of the Proposed Action Checklist items from SM 2.1 written on the vertical axis (or rows). Boxes are constructed so that a particular action can be considered in light of an environmental condition. At this point a diagonal line is drawn in the box representing the intersection of rows and columns to show potential impact. An example of a reduced matrix template for a proposed landfill site development project is shown in figure one.

From figure one, the proposed actions "modifying the environment," "construction," "processing materials," "altering the land," "waste disposal and treatment," "using chemicals," and "possible accidents" impact all three environmental conditions "earth, water, atmosphere and their interactions," "plants and animals," and "use of environment human interests, etc."

The proposed actions "changing traffic" and "management" only impact "earth, water, atmosphere, etc." and "use of environment, human interests, etc." And finally, in this hypothetical situation, "getting resources" and "renewing resources" only impact "use of the environment, etc."

Environmental Conditions

	Earth, Water, Atmosphere and their Interactions	Plants and Animals	Use of Environment, Human Interests, Cultural Status, Man-made facilities and Activities
Modifying the Environment			
Construction			
Getting Resources	No foreseen impact	No foreseen impact	
Processing Materials			
Altering the Land			
Renewing Resources	No foreseen impact	No foreseen impact	
Changing Traffic		No foreseen impact	
Waste disposal and Treatment			
Using Chemicals			
Possible Accidents			
Management		No foreseen impact	

Figure 1. A reduced matrix template for a hypothetical landfill project showing potential interaction between certain proposed actions and environmental conditions.

Activity 5. "How Great is it?"

All students in class determine the extent or **magnitude (M)** of impact each proposed action will have on each of the characteristics and conditions of the environment. Judgments are based on facts. Be prepared for a great deal of open student discussion during class!

Objective: Given the "reduced matrix" with appropriate environmental conditions and proposed actions listed and having a diagonal line in the boxes when these variables interact, the students enter a total group average value from one (least magnitude) to ten (greatest magnitude) in the upper half of the box to designate the extent or degree of impact of the action on the environment. No student materials are required.

Organizing Ideas: Group consensus, average numerical value of degree of impact, and evaluation of the facts.

Class Materials: One large representation of the reduced matrix with variables listed and diagonal lines drawn.

Suggested Procedure:

1. Clarify student questions regarding terms, concepts, and generalizations inherent in the "reduced matrix."

2. Dealing with the facts of the issue, ask students for a show of hands for each value representing how great, or to what extent, the proposed action will have on the environmental variable under consideration.

Note. Use a scale of 1, 4, 7, and 10 requires the class to establish corresponding statements such as "A '1' represents very little impact, a '4' represents some impact, a '7' represents considerable impact, and a '10' represents most significant impact!" The numerical value set of 1, 4, 7, and 10 is used for two reasons; to "force" a value judgment away from a neutral position, and to make computation of an average value simple.

3. Determine an average numerical value to be placed in the upper part of the box split by a diagonal line. This is done by multiplying each value (v) by the number of hands (h) to obtain (v) x (h). Adding these values and dividing by the total number of hands yields the average numerical value. For example, if in your class of 30 students, 3 hands show for the value of 2; 6 show for a value of 4, 12 hands show a for a value of 7; and 9 hands show for a value of 10, the cell would calculate a magnitude of 6.7 as seen in the sample computation.

4. Repeat steps 2 and 3 until the cells or boxes of the reduced matrix have numerical values above the diagonal line in each box. A sample matrix designating the degree of impact for a proposed landfill site project is provided in figure 2.

Environmental Conditions

	Earth, Water, Atmosphere and their Interactions	Plants and Animals	Use of Environment, Human Interests, Cultural Status, Man-made facilities and Activities
Modifying the Environment	4	8	8
[illegible]	10	8	9
Getting Resources	No foreseen impact	No foreseen impact	9
Processing Materials	3	6	8
Altering the Land	4.5	4	5
Renewing Resources	No foreseen impact	No foreseen impact	10
Changing Traffic	3	No foreseen impact	5
Waste disposal and Treatment	8	9	10
Using Chemicals	8	9	9
Possible Accidents	9	4	8.5
Management	9	No foreseen impact	7

Figure 3. A reduced matrix template for a hypothetical landfill project showing magnitude (M) of potential interaction between certain proposed actions and environmental conditions.

Activity 6. "How important is it?"

In this activity, all students determine the significance or **importance** (I) of the plan on the environment. Judgments should be based on the value or importance each individual holds regarding the proposed project. An average figure from one (least importance) to ten (most important), for the entire class, is roughly and quickly calculated. Note: As a homework/lesson planning assignment the student or teacher, respectively, saves the previously used matrix for the next class. Media and citizen activities can be self initiated by students or established by the teacher at or during any of the numbered activities. Again be prepared for a great deal of open student discussion during class! No student materials are required.

Objective: Given the "reduced matrix" with appropriate environmental conditions and proposed actions listed and having average numerical values entered above the diagonal line in the boxes when these variables interact, the students enter a total group average value from one (least importance) to ten (greatest importance) in the lower half of the box to designate the value or importance held by the group regarding the action on the environment.

Organizing Ideas: Group consensus, average numerical value of the sense of importance, value judgements, and personal bias.

Class Materials: One large representation of the reduced matrix with variables listed and computed average numerical values representing degree of impact.

Suggested Procedure:

1. Clarify the notion of a value judgment with the students. Make it clear that in determining importance of the action on the environment, value judgments are accepted provided they are ethical and not prejudiced.

2. Always dealing with values the students hold, ask them for a show of hands as to valued representing the importance of the effect that the proposed action will have on the environment.

3. Determine an average numerical value to be placed in the lower part of the box split by a diagonal line.

4. Repeat steps 2 and 3 until the reduced matrix of interaction has a complete set of numerical values below the diagonal line in each box. A sample matrix designating the degree of impact and the importance of this effect that the proposed action has on the environment is shown in figure 4.

Environmental Conditions

	Earth, Water, Atmosphere and their Interactions	Plants and Animals	Use of Environment, Human Interests, Cultural Status, Man-made facilities and Activities
Modifying the Environment	4 / 6	8 / 6	8 / 10
CONSTRUCTION	10 / 5	8 / 4.5	9 / 10
Getting Resources	No foreseen impact	No foreseen impact	9 / 7
Processing Materials	3 / 6	6 / 7	8 / 10
Altering the Land	4.5 / 4	4 / 1.5	5 / 5
Renewing Resources	No foreseen impact	No foreseen impact	10 / 7
Changing Traffic	3 / 4	No foreseen impact	5 / 7
Waste disposal and Treatment	8 / 10	9 / 8	10 / 10
Using Chemicals	8 / 7	9 / 8	9 / 10
Possible Accidents	9 / 10	4 / 1	8.5 / 10
Management	9 / 10	No foreseen impact	7 / 8

Key: Magnitude / Importance

Figure 4. A reduced matrix template for a hypothetical landfill project showing magnitude (M) and Importance (I) of potential interaction between certain proposed actions and environmental conditions.

Activity 7. "One Voice... .One Vote!"

In this culminating activity, students prepare a written report of the (a) relative merits of the proposed action plan or project, (b) rationale behind the final best choice of action plans, and (c) best plan for the environment and people in the area. Finally, each student votes to accept or reject the recommendations. The balloting follows a format used in some local, state, and national elections with *50%* plus 1 of the voters required for passage. Abstentions are counted as "no" votes.

Objective: Given the completed reduced matrix, the representatives of the Environmental Advisory Council prepare a written and oral report that states (1) the relative merits of the project, (2) a rationale or reason behind the final best choice of action plans, and (3) the recommended best plan for the environment and people in the area. After this each and every student in the class registers to vote, receives a ballot slip (SM 7.1), and votes to accept or reject the recommendation of the Council. Provide sufficient advertisement of the recommendation and the voting date!

Student Materials: Handout (provided in the Student Materials Supplement) BALLOT SLIP (SM 7.1) Only one ballot slip per student is allowed and this must be obtained in the process of voter registration.

Suggested Procedures:

1. Representatives of the Environmental Advisory Council prepare and present the report.

2. Give a concise statement of the recommendation by the Council, type it and print as many ballot slips as there are voters. Use the model ballot slip format provided at the end of this activity.

3. Be sure to make provisions for absentee balloting.

4. Count all ballots openly at the end of the voting period and post the results.

5. Allow time to discuss results and reactions, asking such questions as:

- What are major alternatives? What are costs and benefits of different plans? What technology is available?

- What are the environmental effects of the technologies? What is the most effective plan for project management and how do we pay for it? What are the dynamics of community relations?

SM 7.1
BALLOT SLIP

Recommendation: (typed double-spaced statement of recommendation)

---------- (cut here)----------
tear at this line, check your vote, and deposit this slip into the ballot box

Given the above written recommendation by the Environmental Advisory Council, it is my free choice to vote:

_____FOR THE PLAN.

_____AGAINST THE PLAN.

REFERENCES

Council on Environmental Quality (1971) Statements on proposed Federal actions affecting the environment (Federal Register, Vol. 36, No. 19, pp.1398-1402; No. 79, pp.7724-7729). Washington, D. C. U. S. Government Printing Office.

Leopold, L. B., Clarke, F. E., Hanshaw, B. B., & Balsley, J. R. (1971). A procedure for evaluating environmental impact (Geological Survey Circular 645). Washington, D.C.: U. S. Department of the Interior.

TEACHER REACTION SHEET

Shortly after finishing the unit, complete a separate Teacher Reaction Sheet FOR EACH CLASS using the module. Returning a completed reaction sheet keeps your name active in the file for future announcements, materials and updates.

Teacher _____

School _____

Street _____

City _____ State____ ZIP_____

Grade _____ Number of Students_____

Unit Start Date _____ Unit End Date _____

Indicate whether you used a section by circling either YES or NO.
For each section circled "YES," indicate your reaction to that section.

ASSESSING ENVIRONMENTAL IMPACT	Use?	Reaction?
Background Information	NO YES	poor fair ok good excellent
Act. 1. Community Initiative	NO YES	poor fair ok good excellent
Act. 2. Call Out the Engineers	NO YES	poor fair ok good excellent
Act. 3. The Business Meeting.	NO YES	poor fair ok good excellent
Act. 4. What's the Environment?	NO YES	poor fair ok good excellent
Act. 5. How Great It Is.	NO YES	poor fair ok good excellent
Act. 6. How Important Is It?	NO YES	poor fair ok good excellent
Act. 7. One Voice. One Vote.	NO YES	poor fair ok good excellent

Comments:

RETURN THIS FORM AND WRITTEN COMMENTS TO

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